Farm Machinery
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Lecture – 24
Design a Tractor Drawn Seed Drill for a 40 hp Tractor – I

Dear students, now so far we have discussed about the seed drills; the various design factors, parameters and how to design the various components of a seed drill. You have seen that seed drill attracted on seed drill has various components. For example, they have this hopper in which the seed is kept, then there is a metering mechanism through which the seed is to be metered and then after that we go back down the line and try to place the seed into the soil. And, for that we have these shovels or the tines or sweeps different types of tines or furrow openers which are employed in this and then we have a covering device which covers this seed after it has been put into the soil.

So, we will when we take up the design we in order that you should have some idea about how to design a particular type of seed drill; for that we have taken an example here in this particular lecture which is lecture number 24 in the series and we want that the drawn seed drill should be for a 40 horsepower tractor. Now, let me tell you that most of the tractors which are available in the country maybe about 10 years back we are about 35 horsepower or so and now we are talking of 50 horsepower tractors, slightly because of the use of rotavator in a bigger way. But, then if you design a seed drill for 35 horsepower tractor or a 50 horsepower tractor I think the number of tines etcetera will not be that much vary and that is why we have taken a 40 horsepower tractor take an example of a 40 horsepower tractor because 35 or 30 horsepower and 50 horsepower, so, on an average about 40 horsepower tractor.

Now, we have put this class the session into different parts for example, this is part I where we will talk about how do we go into details of the power utilization and that what are the steps we should be taken in sequence and then we will see that how what are the parameters, what are the equipment, what are the components we design in part I and what are the things we divide in part II and so on and so forth. So, let us follow the slides and go ahead about this particular design.

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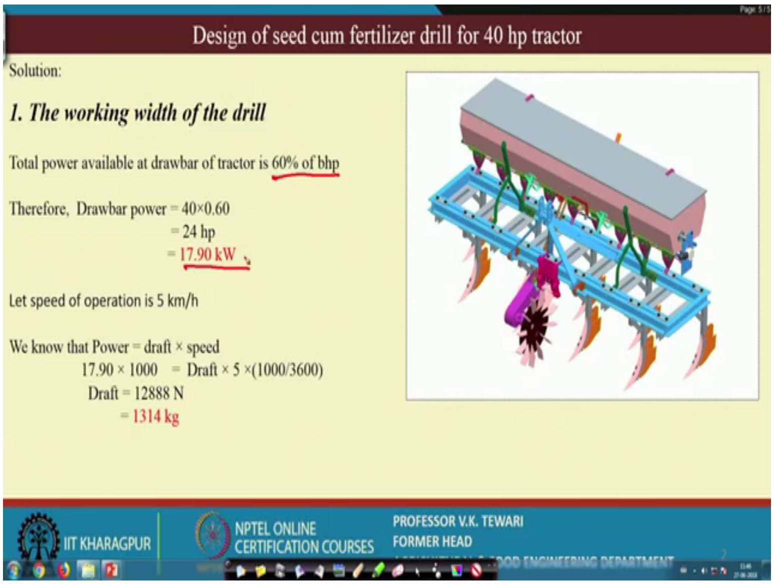

Well, the working width, it is very important because whether it is seed cum fertilizer drill or if you drill alone you must know what is the working width of the drill this is very important because the you will have several requirements. For example, if the tractor you know that the tractor has a certain width and that width mostly we take with respect to the field trade of the tractor, but then wheel trade is the center to center distance between the wheels of the tractor. And, here we would like to know what is the maximum working width of a drill or a seed cum fertilizer can be taken because the wheel trade is varying from say 48 to 72 inches in the various orders, but then you will have to take slightly more than that and finding out as to how much is available, how much maximum you can take as the width of the seed drill.

So, for that what we do is we would like to know: what is the amount of power that is available with us. Well, you know that the power available for a tractor is about 40 horsepower that we have assumed. So, 40 horsepower tractor is the power, but the power which is available at the drawbar is very important and in my previous classes I have explained to you, that is not possible to get more than about 60 percent of power from the actual power of the tractor onto the drawbar and that is why we will then assume this part and it is very reasonable to assume that 60 percent of the power of the tractor is available for this particular job.

So we have assumed here, we have assumed here 60 percent of the bhp, that the 60 percent of power is available with us and hence we will see that the drawbar power available for this particular tractor of 40 horsepower is about 17.90 kilowatt. Well, they we have converted this into kilowatt, so that you will be you are very much familiar with the system and that is why you have converted into kilowatt. Now, let us p find out the speed. Well, this also is a point of consideration on for on the part of the designers because we the various speeds which are taken over the years if you go through the literature you will find that is vary between 4 to 5 sometimes 6 kilometer per hour of the seeding speed depending on what type of seed is there and what is the soil in which the seed drill is being operated and what is the size of this.

So, we have taken for example, in order to give you an idea we have taken 5 kilometer per hour is the speed of operation. So, with this speed now we will see: how much is the draft available. Now, here we assume that the although the three-point linkage is the connection where drawbar connection where our the seed cum fertilizer drill is attached and we will see that this attachment when it is actually in the field is a straight one and we are in a position to find out the draft of that. Although, in order to find out the actual draft for three-point linkage connection is slightly different, but we will then assume that what is the total draft available on the basis of the power available and the speed at which we are going.

So, we know that what is the power available and what is the draft with us. So, using this we are in a position to know that this draft is about 1314 13 1314 kg; 1314 kg 1314 kg. This is an example; you remember that we are taking an example to tell you as to what are the various aspects of this particular design. So, you must always consider that this is a designers way of looking at the various parameters and their values.

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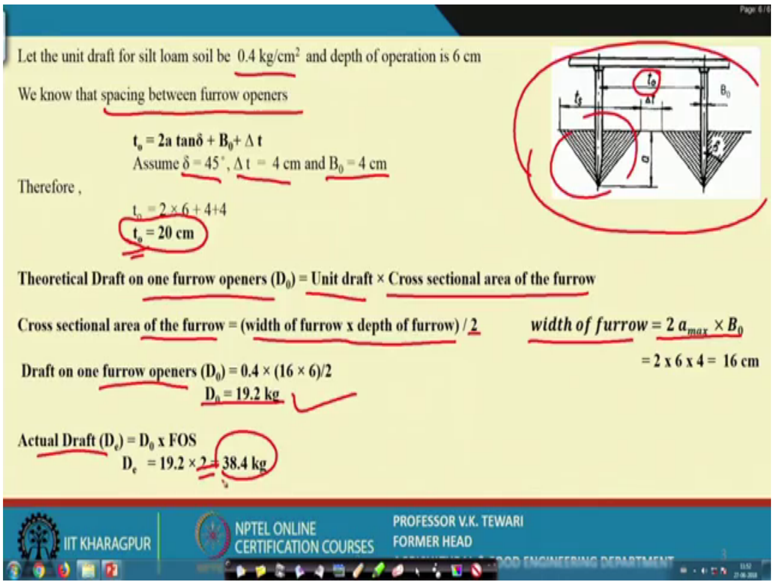

Now, let us so, we have found out the draft now we must know because this is the draft which will be encountered by the total number of the furrow openers which will be there in the seed drill. So, for that we need to know in a particular soil, now we have considered here is lateritic sandy loam or silt loam soil and in this case the availability of the unit draft from the literature is about point 0.4 kg per centimeter square. This is the value which is already available

Now, depth of operation is 6 centimeters, we have taken 60 millimeter the depth operation because this you have seen that are the these your seeds should be below the soil surface of the soil at reasonable depth, because you cannot put it very high you cannot put it very very much above and that is why a reasonable value of about 6 6 or 60 millimeter is taken. Now, you may recall that we had discussed about the furrow openers and the design of the furrow openers and the shape of in which the furrow openers are there. So, if you see that this is the design which we had considered in our earlier design discussions and so, from here we will take a clue and then try to find out what will be the number of tines etcetera that we will design.

Now, you can see here that t 0 is the spacing between the furrow openers, t 0 is the spacing between the furrow openers. So, this t 0 as per the drawing given here, you can see that the center to center distance between the two sweeps which are shown to you here. And the various values which have already we discussed to you we have taken that delta is about 45 degrees and the delta t is 4 centimeters you can we are going ahead 4 centimeters and millimeters. So, please try to understand that either you can take millimeter or a centimeter. So, you must be careful about these units which we are taking here. So, you have taken in centimeters and B 0 is about 4 centimeters

Now, these we had discussed when we designed the details of the furrow openers I had discussed and that is why I am just assuming that you will definitely recall and try to take these values. Accordingly when we put this we get a value of t 0 is equal to 20 centimeters; that means, these three 0's in the center to center distance between these two will be 20 centimeters, this is one important things.

Because once you know how much is the distance and what is the draft required now, there you will be in a position to know what will be the size of the furrow and how we can find about the total number of furrows that has to be created. So, the theoretical draft on one furrow opener is unit draft into cross sectional area of the furrow. This is very simple, you can you can have a look at this and then you should be able to and we says that this unit draft once we know the unit draft value and the cross sectional area of the furrow we will be in a position to get the draft on one furrow opener. So, that this is what we have got.

Now, cross sectional area is width of furrow into depth by 2, this is very simple from the formula which we has been told to earlier and width of furrow is twice max B 0. So, the using this then draft on one furrow opener D 0 is given by this because you can see 0.4 and this is 16 here. So, into depth operation 6 and the divided by 2, hence this comes to from 19.2 kg. Now, this is at a theoretical value which we have got 19.2 kg, draft on one furrow opener. Now, remember that there will be encounters when this when the seed drill is moving into the soil. So, we need to have some factor of safety.

So, we will take a higher side factor of safety although may not be essential that you can go about one say about 1.1, 1.2, 1.5, but we have taken 2 times just to see that where do we lend up in the total number of furrow openers that we will be there within the draft capability of the tractor which is going to be used. So, with this factor of safety of 2 we are getting that the actual draft required is about 38.4 kg; now, this 38.4 kg could you can take this to be around figure either 40 kg or so. So, about 40 kg taking into consideration the factor of safety as well as the unit draft of a particular of the particular soil which we have thought of. Now, we will use this. Not necessary that we can take 40 kg we can take 38.4 kg also, but we have taken it I will show you what we are doing.

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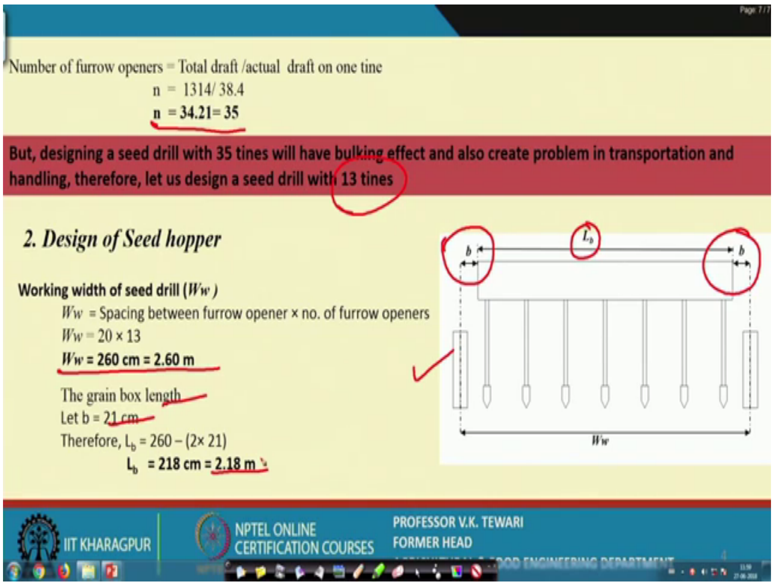

Well, using that so, once you know that this is the draft total draft available from the drawbar and the Maxwell draft on one tine is known. So, it is very simple you are in a position to do this now n is 35. Now, you have got a value of the number of total number of furrow openers as 35. Here as an engineer you would like to have some tradeoff between what should be done. Now, if we go back to what we discussed earlier we said that if there are 35 or say is said that if there are 11 in number, then 6 will be at the back and 5 will be in the front like this. So, if we talk of 35 in 35 minutes there will be 18 at the back and 17 should be in front.

Now, you imagine that if this 35 are to be actually at a distance of 20 centimeter, so, what is the total width that you are going to get the total width that you are going to get is a pretty high in number, pretty high in number is it is something about 7 meters or so, because the 35 tines and then you will multiply by 20 centimeter which is the width. So, you will get about 7 meters or so. But, what we have seen that in case of as I said earlier that the width of the tractor back width. We are talking of 48 to a 76 inches is the field trade. Now, if we take that starting point, so, we are finding that about 76 or say 80 inches the roughly this comes to about 200 mm or 200 centimeters or so. Now, then this means that about 2 meters. So, if you take care of the diameter of the wheel on both sides then roughly you get about 2.4 – 2.5 meter.

Now, this 2.4 – 2.5 meter is the width which will be a width which will be utilized when, but then you see if you put 7 meters there will be several difficulties. For example, the unit while transportation it has to be folded then you need to have arrangement for folding and that will add up unnecessary cost. Then if you think that this has it has to be lesser, then the total weight which will be there on that on the track tractor will also be slightly more than that then if you are thinking that we should decrease now how much we should decrease.

So, an idea is that we have heard of the different types of tines we are getting a tine which is about 35 in number on the basis of the draft which is available. And, in fact, if you recall I had also talked of that matching of implements to the power source has a greater bearing and it is a mystery, still we are not in a position to match as much possible. Because, you have seen that 60 percent of the power is available of the tractor, but then we are not in a position to put a 35 tine seed drill seed cum fertilizer drill because of many it is consideration. So, soil is another consideration in this case.

So, we have to think of fault should be and then headland while rotation, while you are taking a turn, while turning at the headlands so, much of a down time of the actual work will be there. So, field efficiency will come down as such the field efficiency of a the drills which we have found over period is varying between 70 – 75 percent or so. So, if we consider these into picture we can comfortably say that you can take say a value of about 19 or 17 or 15 or 13 number of tines. This is this is what you can take 19 17 15 or 13.

Now, in this present case we have taken 13 number of tines just to give you an example you can take 15 and get a value, you can take 17 and get a value, you can take 19 and then get a value because then you will have to have 10 in the back and 9 in the front. And, accordingly the widths etcetera you have to see because headland management and the power loss unnecessary over there is very important, which you should see that a the moment you go for very large width the headland management will be difficult and then you will not be in a position to get high field efficiency of the unit. So, the work output will be reduced.

So, you have to have a tradeoff and in that case that is why you will not get the seed cum fertilizer drills, not more than 13 or so. So, we have taken a value 13 to explain you here. Now, so, we have taken value of 13. Now, once we know the value of 13. So, by convention as we explained you earlier in the earlier class that 7 will be at the back and a front row will be 6, 6 number of tines.

So, working width of the seed drill then here is roughly we are taking about 2.6 meter because as I said we will take 13 and then the grain box length. Well, this is grain box length you can take a grain box length which is also equal to 2.6, but then what we what is important is we look into the values if you if you recall this figure which we had also shown you earlier then these two these two values need to be considered with the respect to the wheel.

So, while taking into consideration we have found that this value b is generally about 20 to 22 centimeters here we are taking 21 centimeters. For example and therefore, the length L b this length of the you can say the length of the seed drill working length of the box will be about 2.18 meters this is what is the justifiable and a tradeoff between all factors which we have considered. Now, let us go ahead.

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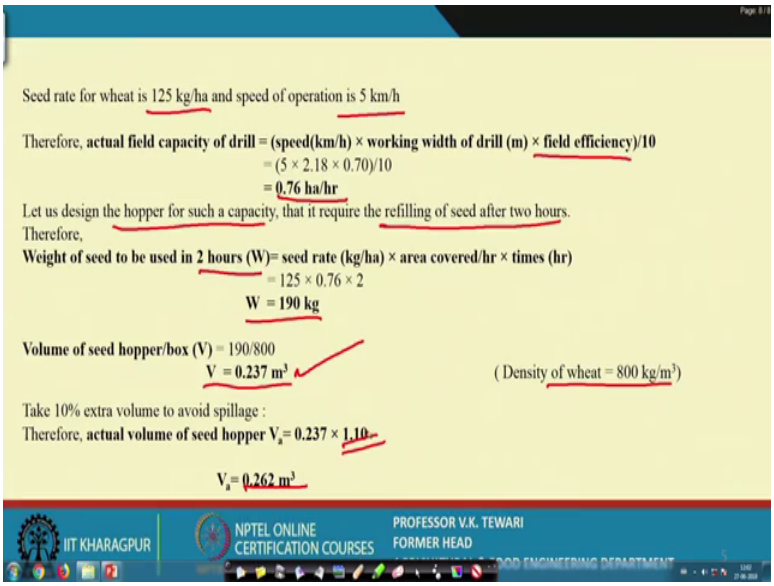

So, seed rate for which ok, now, we have taken that what should be the length of this. Now, we will let us talk about the seed rate. Now, seed rate for which we will take wheat as the as the crop to be sown and we have already taken 5 kilometer per hour this is seed rate. So, the actual field capacity of the drill will be speed here the working width and the field efficiency and I said that field efficiency cannot be more than 70 to 75 on the normal basis or on the basis of experience and the literature available over the world people have done. So, we can take comfortably let us take 0. 7 and that is how using this we are getting. So, much hectare 0.76 hectare per hour; that means, in 1 hour 0.76 hectare will be the covered by this particular disc.

Now, in order to design the hopper for such a capacity it is required to refilling the seed for 2 hours. Now, we would like to see whether when we have to put so much per hour it will cover about 0.6 hectare. So, in 2 hours it will cover about twice of this. Now, generally we would not like that the filling should be either once filled so much then it will continue for 4 hours because, then human factory is considered into it because there is a human being who is there on the tractor. And, definitely he would like to get off for some time and while he is doing the job and that is why a comfortable value of from all considerations we can take the 2 hours is enough time.

So, let us say that for 2 hours he will be in a position to continue and the seed which is there or the fertilizer which is there also will last for 2 hours. So, if you take that into consideration what we get is for 2 hours at this rate we are getting about 190 kg. So, 190 kg we need to put and then this 190 kg has to be there inside the hopper. So, what is the volume of this? Then simple we know the weight of this and then using the density of the wheat we can get that this is the volume. So, this is the volume which we have got of the hopper.

So, we know that we need to have see this is the volume, but the moment we are talking of the actual design which will be there, we have seen out of our experience and you might have also seen that there has to be a free board. We need to get certain free board and as we discussed in the theory you found that there are certain level which remains not filled and it is also helpful for you. So, we need to take care of that little bit of free board to be added and then which if you add that free board what we get is instead of 237 we are getting a value 0.26 2 meter cube using the 10 percent of extra avoid spillage. So, that there is no spillage and we are in a position to get that.

So, this will be the total volume of the material of the hopper. So, that hopper should be having this material plus certain free board, so that the spillage does not take place when it is filled up for 2 hours,.

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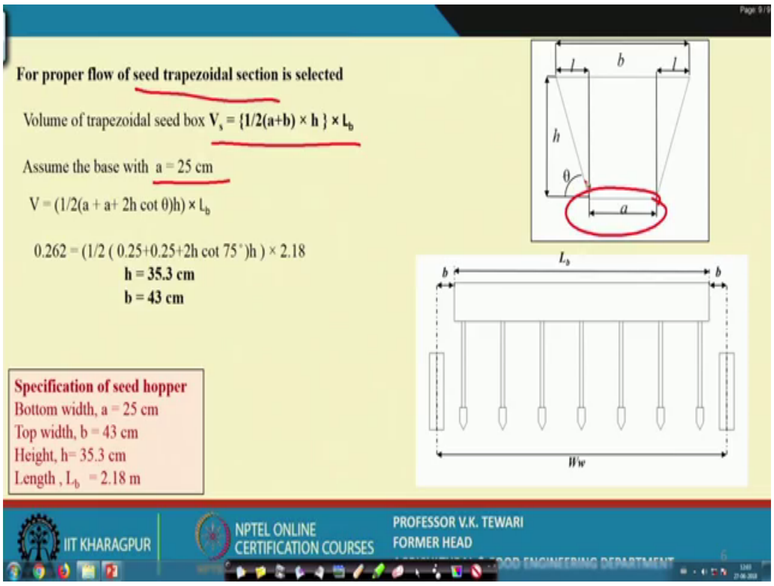

So, for proper flow of seed, let us assume that trapezoidal section. Well, we had discussed this that trapezoidal section is the one section which is good and it takes care of the angle of response of the material or the seed. Therefore, we have assumed here that the trapezoidal section seed trapezoidal section is the one which is selected. So, for a trapezoidal section this is known to you I did not explain again because we have talked of this earlier and what we assume is we need to have some idea about this, because we know the total length, but we must know about the base and I remember that in that base what we do put is either the seed plate or the metering shaft which we which will have the choro may be small baffles in case of fertilizer.

So, in order to take care of that you need to have about 20 – 25 centimeters the width, the base of that particular hopper. So, that is why this one we will assume out of the experience and that is why here we have assumed about 25 centimeter as this. So, this value is about 25 centimeter this value we have assumed 25 centimeters. Now, taking this then we are in a position to get h and b from this; just putting those values into this equation which we know we will be in a position to get these values of h and b. And, therefore, the specification of the seed hopper which we have designed is bottom width is taken as this much, the top width is this, then height is 35.3 and the length is 2.18 meters.

So, the this is the value which of our hopper. Now, if you are thinking of this fertilizer drill a similar arrangement and you can take a similar material of construction also for the seed fertilizer drilled also. So, I need not explain to you that what will be the size of the fertilizer drill, but then this is the side. So, we can see that specification of seed hopper seed cum fertilizer drill hopper that was seed will be one and similar will be another one because they sit side by side if you have seen the drawing or you have seen the machine because I have explained to you in the field. So, then we have got the details of seed hopper.

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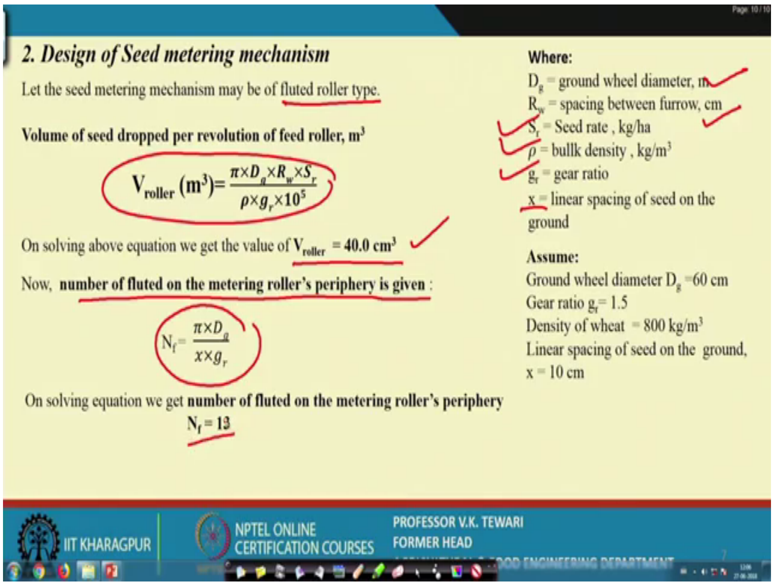

Design of seed metering mechanism; well, here I did not go because just previously my previous lecture was that we had talked of the seed metering mechanism. So, here also we will talk of the seed metering mechanism where we know that the power is taken from the ground wheel and then the power transmission goes to the seed metering mechanism and the seed metering mechanism you can have different types of a mechanisms, actually which will carry the seed and then put into the seed tube. And, we had discussed at length about the fluted roll type which is one which is very much popular. You can take another type also which we have discussed, but then we have discussed about these.

Now, that is why we will take fluted roll type of the and here the volume is given by this. I think all are known to you because D g is the ground wheel diameter here the spacing between furrow, then S r is the seed rate, the bulk density the gear ratio. In fact, the gear ratio g r here may be that you will find that the other one was bigger capital G, but here smaller g does not matter, but then you can this. So, x is the linear spacing of seed on the ground. This is the linear spacing of seed on the ground.

So, using and solving this we get that V roller is about 40 centimeter cc. Now, number of what will be the number of fluted rollers is the periphery is given by this, simple because we know the ratio, we know the spacing that we want. So, we should be in a position to get this on solving we get N f is equal to 13. Now, this is the value which we have got, and you will find that depending upon the size and the tradeoff which you want to have and the total size of the seed drill you can take various values of this number flutes about varying from 8 to 12, 13 or so. We have got 13 value, so, we will take this value.

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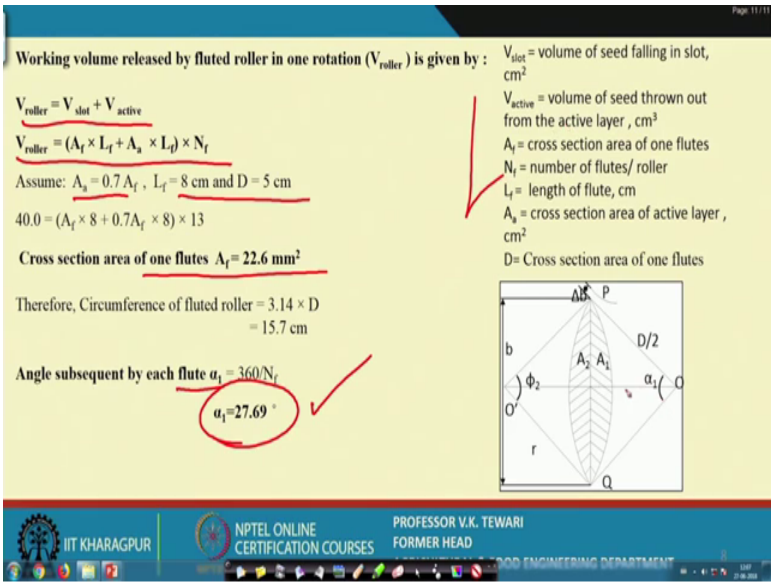

I need not explain much here because you have gone you have understood all these details and these are known to you that what is the wheel here, what is V roller and then the values of course, these values which we have taken or the extended values which we have taken from literature. So, we need not describe talk to you or describe this very much, but because those are all known to you. So, only the values which you can just check and find out that these are given to you here and subsequent the angle which are were it is important for this is 27.69. These details are go given over here and this is one which is known to you. So, I need not explain to you here about working volume released by fluted roll in one rotation of this, it is just comes as from here.

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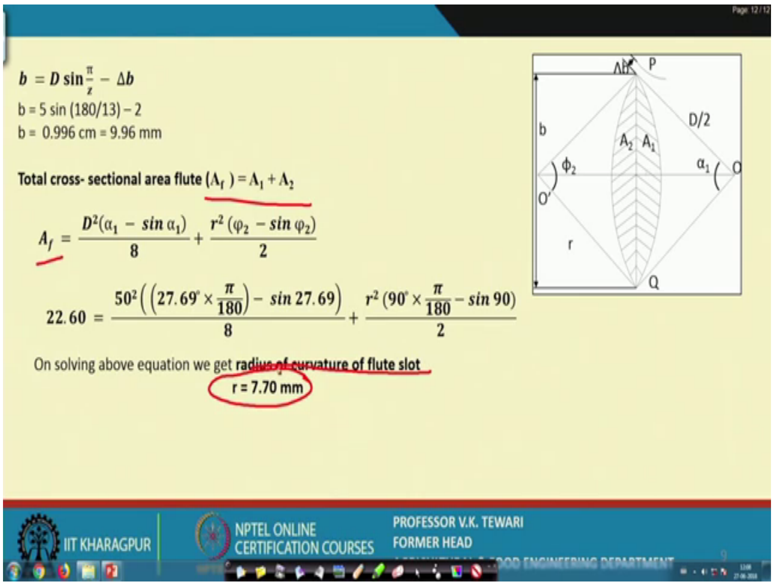

So, using that the same concept now, we are now in a position to get the radius of curvature of the flute, this is important. So, using A f here and using the values of A 1, A 2 which you know already explained to you. So, you will be in a position to get the value of r which is the radius of curvature which is of importance to us. So, you will know now that what is the length of the flute and what is the radius of curvature. You know the total diameter of the flute when it is made. So, you will be in a position to find out this.

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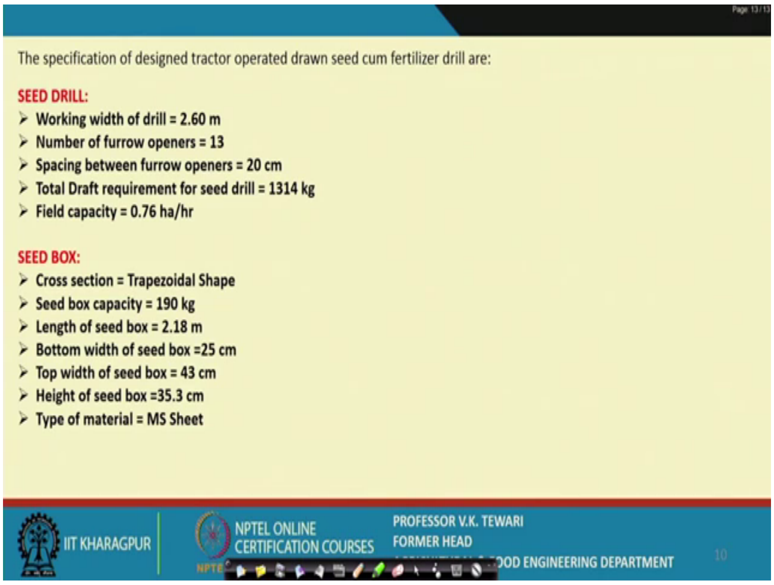

So, as such the specification if you get then these are the specification design tractor part and seed cum fertilizer drill, seed drill details are given here, the working width, the number of furrow openers spacing between the furrow openers, total draft requirement, then the field capacity we have got about 76 0.76 hectare per hour, then the seed box, the details of seed box we have already discussed. Well, material of construction we have taken here material of construction to be MS and thickness etcetera, please remember that these thickness etcetera are dependent what is available to you.

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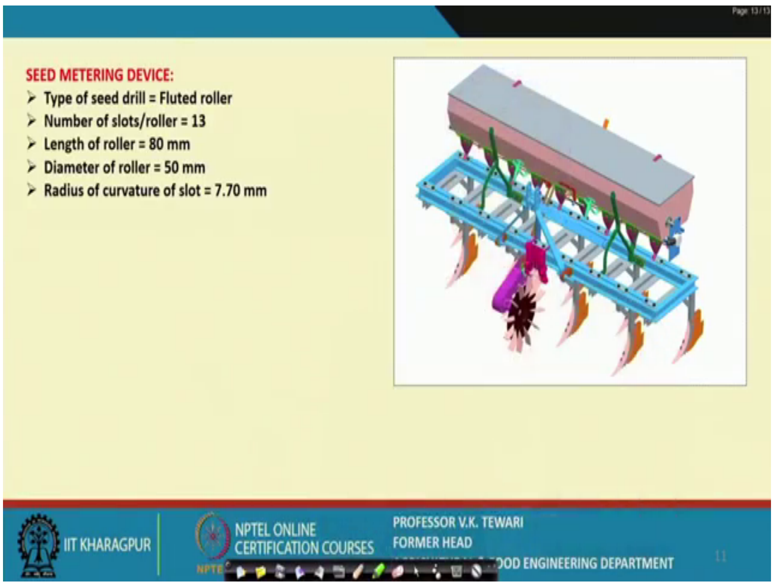

The seed metering device; well, the seed metering device, the type of seed metering device we have taken a fluted roller, then the length of the slot, length of the roller, then the diameter etcetera and radius of curvature which we got earlier is given over here.

Thank you very much.